IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
Before the Board of Patent Appeals and Interferences

IFW AF 2881

In re Patent Application of

LEWIS et al.

Serial No. 09/786,469

Filed: March 5, 2001

Title: OPTICAL PHASE DETECTOR

Atty Dkt. 124-844
C# M#

TC/A.U.: 2881

Examiner: P. Gurzo

Date: September 29, 2004

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Mail Stop Appeal Brief - Patents
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Patent Application of

LEWIS et al. | Atty. Ref.: 124-844

Serial No. 09/786,469 | Group: 2881

Filed: March 5, 2001 | Examiner: P. Gurzo

For: OPTICAL PHASE DETECTOR

* *

APPEAL BRIEF

On Appeal From Group Art Unit 2881

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* *

September 30, 2004

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF

Sir:

I. REAL PARTY IN INTEREST

The real party in interest in the above-identified appeal is QinetiQ Limited by virtue of an Assignment from the inventors to the Secretary of State for Defence recorded March 5, 2001 at Reel 11727, Frame 720 and a subsequent Assignment from the Secretary of State for Defence to QinetiQ Limited recorded February 20, 2002 at Reel 12831, Frame 459.

II. RELATED APPEALS AND INTERFERENCES

There are believed to be no related appeals or interferences with respect to the present application and appeal.

III. STATUS OF CLAIMS

Claims 1-26 and 39-41 have been cancelled, claims 27-38 and 42 rejected and claim 43 withdrawn from consideration. The Examiner contends that claims 27-38 and 42 are unpatentable under 35 USC §103 over the cited prior art and claim 43 is withdrawn from consideration.

IV. STATUS OF AMENDMENTS

No further response has been submitted with respect to the Final Official Action in this matter.

V. SUMMARY OF THE INVENTION

The present invention relates generally to a laser stabilization apparatus and specifically to a device for stabilizing the output frequency from a laser source of radiation.

As noted in the background of the invention portion of Appellants' specification, optical phase detectors are utilized for determining the phase difference between two input signals. Conventionally, optical phase difference

measuring techniques have utilized two interfering beams to form an interference fringe pattern and measuring the fringe pattern as it moves across a camera face.

Disadvantages of such type of measurement are that it relies upon counting of fringes and interpolation between fringes to measure phase or position accurately. In many applications high spectral purity, i.e., stability, in laser radiation is required. (Numerous examples are discussed in the second paragraph on page 2 of Appellants' specification). However, lasers of well-defined frequency (or wavelength) and high spectral purity tend to be expensive and complex.

While laser diodes are a widely used and inexpensive source of laser radiation, they have particularly poor spectral stability and often can support several modes simultaneously. In order to overcome the problems of poor spectral quality and to have the ability to stabilize the frequency of a laser, a laser stabilization apparatus is highly desirable. Appellants found that conventional lasers could be stabilized by the use of a laser stabilization apparatus which comprised four components:

- a frequency discriminator for providing two primary optical outputs;
- a means for providing a relative delay between the two optical outputs;
- a particular optical phase detector for generating an output difference signal indicative of the phase difference between the two outputs; and
- a feedback for feeding back to the laser the output difference signal.

In particular, appellants found that the optical phase detector utilized needed to produce two combined optical outputs where separate detectors detected the intensity of each of the two combined optical outputs and provided electrical signals indicative thereof. A means for measuring the difference between the two electrical signals and for generating an output difference signal was also provided. It was this output difference signal which is ultimately fed back to the laser in order to provide the stabilizing feedback.

Therefore, the claimed laser stabilization apparatus requires the four specified components, i.e., "**a frequency discriminator apparatus**" for producing two primary optical outputs, "**a means for introducing a relative delay**" between the outputs, "**an optical phase detector**" for providing an output difference signal and "**a feedback means**" for applying an output difference signal back to the laser to be controlled.

The present invention is particularly characterized by the specific optical phase detector comprising "**means for receiving** two primary optical outputs **and producing** two combined optical outputs," a detection means for detecting "**the intensity of <u>each</u> of the two combined optical outputs**" and for converting the intensity of the outputs "**into an electrical signal**" and a means for measuring the difference between the two electrical signals and "**generating an output difference signal**."

VI. ISSUES

Whether claims 27-38 and 42 are obvious under 35 USC §103 over Ooi et al (U.S. Patent 5,917,628) in view of Logan, Jr. (U.S. Patent 5,204,640).

VII. GROUPING OF CLAIMS

The rejected claims stand or fall together based upon the patentability of independent apparatus claim 27 and independent method claim 42 as described in the argument portion of this Appeal Brief.

VIII. ARGUMENT

1. Discussion of the References

Ooi et al (U.S. Patent 5,917,628) shows an optical time-division multiplexer capable of supplying a stable output signal. Specifically, Ooi teaches an optical modulator 62 which produces two optical outputs, one of which passes to optical modulator 63 and the other to optical modulator 64. The two optical modulators are provided with opposite polarity signals, thereby delaying or accelerating the phase of the laser light passing therethrough. A single combined optical signal is provided at output 76 through optical fiber which is twice the frequency of the system clock signal.

Ooi fails to teach any optical phase detector having the claimed characteristics, i.e., a means for receiving two primary optical outputs, as no

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structure other than optical coupler 65 in Ooi receives the two combined optical outputs. There appears to be no detection means for detecting the intensity of **each** of the two combined optical outputs or providing electrical signals indicative of the **two** optical output signals. Ooi contains no disclosure of measuring the difference between the two electrical signals and **generating an output difference signal**. Moreover, the Examiner admits on page 3, first full paragraph, that Ooi fails to teach that there is any feedback "connected to the laser (11)" and this is clearly shown in Figure 7.

Additionally, the Examiner has not pointed out how the Ooi reference is directed towards providing laser stabilization to a laser source of radiation or how it solves the problem of poor stability in inexpensive sources of laser radiation which is the problem solved by the present invention. Further, the Examiner fails to identify any reason or motivation that would lead one of ordinary skill in the art to combine the Ooi reference with any other reference in an attempt to provide an output frequency stabilizer for a laser source of radiation.

Logan, Jr. (U.S. Patent 5,204,640) discloses a widely tunable laser oscillator using analog fiber optic delay line as a feedback mechanism. Logan specifically discloses two slightly different constructions for an optical phase detector, as shown in Figures 6a and 6b. As described in column 6, lines 7-18 with respect to Figure 6a, one optical output is received by photodetector diode 70 and the electrical signal from this detector is used to modulate the other optical

beam using light wave modulator 72. The **single** modulated beam output from modulator 72 is then detected by detector 74. This embodiment of Logan clearly fails to teach an optical phase detector which detects the intensity of "**each** of the **two** combined optical outputs" or provides electrical signals indicative of **each of the outputs**. Clearly there is no such electrical signal indicative of each of the two optical outputs.

In Figure 6b, Logan also discloses another optical phase detector as discussed in column 6, lines 30-40. Here, the two optical beams are combined into a single optical beam which is then detected by photodetector 82. Again, there is no detection of intensity of **each of the two beams** and then a measurement of **the difference between the two** electrical signals to generate a difference signal.

Moreover, there is no suggestion in Logan that the problem of stabilizing laser output frequency can be solved by providing feedback of a difference signal between two electrical signals.

2. Discussion of the Rejection

Claims 27-38 and 42 stand rejected under 35 USC §103 as being unpatentable over Ooi in view of Logan. To the extent it is understood, the Examiner appears to admits that while Ooi suggests a feedback system, it is not connected to the source laser. The Examiner suggests that because Logan teaches

feedback to a laser, it would be obvious to somehow combine Logan with Ooi in the manner of Appellants' claims.

3. The Errors in the Final Rejection

There are at least three significant errors in the Final Rejection and they are summarized as follows:

(a) No prior art reference teaches the claimed "optical phase detector;"

(b) There is no suggestion or motivation for the combination of the cited references; and

(c) The cited references would lead one of ordinary skill in the art away from the combination of those references.

(a) No prior art reference teaches the claimed "optical phase detector"

The Court of Appeals for the Federal Circuit has consistently held that "the PTO has the burden under §103 to establish a *prima facie* case of obviousness." *In re Fine*, 5 USPQ2d 1596, 1598 (Fed. Cir. 1988). The Court has indicated that the PTO "can satisfy this burden only by showing some objective teaching in the prior art . . . ." *Id.*

Appellants' independent apparatus claim 1 and independent method claim 42 specify a particular optical phase detector which, in response to the received "two primary optical outputs" from the means for introducing a relative delay, provides an electrical output difference signal indicative of the difference in phase

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between the two primary optical outputs. The claimed optical phase detector does this by "producing two combined optical outputs," then "detecting the intensity of **each** of the two combined optical outputs" (emphasis added) and then provides a means for measuring the difference between the **two** electrical signals and generating an "output difference signal."

Therefore, in order to establish a *prima facie* case of obviousness, it is incumbent upon the Examiner to show that the claimed structure of Appellants' "optical phase detector" is actually disclosed in at least one of the cited prior art references. A detailed analysis of each reference will show that neither teaches Appellants' claimed optical phase detector.

(1) Neither of Logan's two embodiments, Figures 6a or 6b, teach the claimed optical phase detector

While the text of the Final Rejection is identical to the text of the previous Official Action, the Examiner states under the new "Response to Arguments" portion on page 4 of the Final Rejection that Logan teaches a "phase detector" implying that this is the same as Appellants' claimed "optical phase detector." This is demonstrably incorrect.

The Examiner apparently fails to appreciate that Appellants' claim states "an optical phase detector, wherein the optical phase detector comprises" and then there is listed three means-plus-function recitations of elements which make up the

claimed optical phase detector which must be included in any device purporting to be the claimed "optical phase detector."

It is noted that when claimed structure is recited in means-plus-function form the Examiner is required to refer to Appellants' specification for the corresponding means, and the claim is interpreted to mean that "means" and equivalents thereto. However, even assuming for the purpose of argument that Logan teaches Appellants' claimed "means for receiving," there is clearly no detection means "for detecting the intensity of each of the two combined optical outputs."

In neither Figure 6a nor Figure 6b is there disclosed **two** separate detectors which would be required to detect the intensity of **each of the two** optical outputs. Rather, in Figure 6a, one optical output is detected and used to optically modulate the other optical input, and the resultant single combined optical output is then detected in the phase detector 74 to provide **a single electrical output**.

In Figure 6b, the two optical beams are optically combined in beamsplitter 80 to form a single optical output and then that single optical output beam is detected by photodetector 82 to provide a single electrical signal. Because both Figures 6a and 6b in Logan teach only the provision of a single modulated output, there is no "means for measuring" the difference between **two** electrical signals.

Because the burden is on the Patent Office to establish that Logan teaches the elements and method steps set out in claims 27 and 42 and because the

Examiner has failed to meet this burden, Logan does not support the rejection of Appellants' independent claims.

(2) While Ooi teaches a directional coupler, he fails to teach any "detection means" or "means for measuring the difference between the two electrical signals" as required by the claims

On page 3, first full paragraph of the Final Rejection, the Examiner admits that Ooi does not teach feedback "connected to the laser (11)" and this admission is appreciated. However, the Examiner fails to appreciate that while Ooi teaches a directional coupler, it fails to teach Appellants' claimed "detection means for detecting the intensity of each of the two combined optical outputs" or any "means for measuring the difference between <u>the two electrical signals</u>" (emphasis added) or "generating an output difference signal."

Again, the burden is on the Patent Office to establish how or where the specific optical phase detector recited in Appellants' claims is shown or rendered obvious in the cited prior art. Merely stating that the prior art references have a box labeled "optical phase detector" in the case of Logan, or could be disclosed in the case of Ooi, does not meet the requirement of establishing a *prima facie* case of obviousness.

In view of the above, clearly neither cited prior art reference contains any disclosure of the claimed "optical phase detector," especially one including the three recited elements (the "means for receiving," the "detection means" and the

"means for measuring"). In view of the Examiner's failure to establish a *prima facie* case of obviousness, the rejection of independent claims 27 and 42 fails and therefore the rejection of claims 28-38 also fails.

(b) There is no suggestion or motivation for the combination of the cited references

In order to avoid examiners picking and choosing elements from various references and then combining them with 20/20 hindsight, the Court of Appeals for the Federal Circuit has set out guidelines to aid the PTO in meeting its burden of establishing a *prima facie* case of obviousness. In the case of *In re Rouffet*, 47 USPQ2d 1453, 1457-58 (Fed. Cir. 1998), the Federal Circuit held

> "to prevent the use of hindsight based on the invention to defeat patentability of the invention, **this court requires the examiner** to show a motivation to combine the references that create the case of obviousness. In other words, **the Examiner must show reasons** that the skilled artisan, confronted with the same problems as the inventor and with no knowledge of the claimed invention, would select the elements from the cited prior art references for combination in the manner claimed." (emphasis added).

It is noted that neither of the cited prior art references recognize, let alone address, the problem discussed and solved in Appellants' specification, i.e., the provision of a stabilization system for stabilizing the "output frequency from a laser source of radiation." Logan deals with a tunable oscillator which utilizes analog fiber optical delay line for stabilizing an oscillator, and Ooi teaches optical time-division multiplexer capable of supplying a stable output signal.

Neither prior art reference teaches or suggests the combination of elements or method steps set out in Appellants' independent apparatus claim 27 and method claim 42. Because Logan and Ooi are not directed to the solution of the problem set out in Appellants' specification, the Examiner has failed to meet his burden of "showing a motivation" or "reasons" that a skilled artisan confronted with the **same problems** would select the elements from the cited prior art references for combination in the manner claimed.

In view of the above, it is clear the Examiner has simply failed to meet the required burden of establishing a *prima facie* case of obviousness over the cited prior art references.

(c) The cited references would lead one of ordinary skill in the art away from the combination of those references

The Ooi reference suggests that time-division multiplexing can be used, and, as admitted by the Examiner, there is no need for feedback to the laser 11. While Logan suggests that feedback can be used, neither reference suggests combining (1) a means for receiving, (2) a detection means and (3) a means for difference measuring as set out in Appellants' claimed optical phase detector.

In fact, to the extent either reference relates to the provision of a stable output frequency from a laser source of radiation, their suggestion that no feedback is needed (in Ooi) or that a single detector can be used (in Logan) would

clearly tend to lead one of ordinary skill in the art away from Appellants' claimed combination of elements in the recited optical phase detector.

The Court of Appeals for the Federal Circuit has consistently held that it is "error to find obviousness where references 'diverge from and teach away from the invention at hand'." *In re Fine*, at 1599. In view of the above, both the Logan and Ooi references would lead one of ordinary skill in the art away from Appellants' claimed combination of elements resulting in Appellants' optical phase detector which in combination with the other structures provides a laser stabilization apparatus.

IX. CONCLUSION

While the Examiner has cited various elements shown in the cited prior art references and some of those elements are recited in Appellants' independent claims, the Examiner has failed to show any teaching of the claimed "optical phase detector" comprising the three recited elements. The Examiner's ignoring of the structure of Appellants' claimed "optical phase detector" is indicative that the combination of elements simply is not disclosed in the cited prior art references.

The burden is on the Examiner to show where the prior art discloses Appellants' claimed structures, and he has failed to meet the burden of showing where any "optical phase detector" is disclosed in the prior art. Additionally, the Examiner has failed to provide any reason or motivation for combining the

references and has apparently ignored the fact that the references actually teach away from the claimed combination of elements.

Thus, and in view of the above, the rejection of claims 27-38 and 42 over the cited prior art is clearly in error and reversal thereof by this Honorable Board is respectfully requested.

Respectfully submitted,

NIXON & VANDERHYE P.C.

By: ______________________
Stanley C. Spooner
Reg. No. 27,393

SCS:kmm
Enclosures
Appendix A - Claims on Appeal

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APPENDIX A

Claims on Appeal

27. A laser stabilisation apparatus for stabilising the output frequency from a laser source of radiation, the laser stabilisation apparatus comprising,

a frequency discriminator apparatus comprising input means for receiving a primary optical input from the laser and for producing two primary optical outputs,

means for introducing a relative delay between the two primary optical outputs ,

an optical phase detector, wherein the optical phase detector comprises

means for receiving the two primary optical outputs and producing two combined optical outputs,

detection means for detecting the intensity of each of the two combined optical outputs and converting the intensity of each of the combined optical outputs into an electrical signal, and

means for measuring the difference between the two electrical signals and generating an output difference signal,

feedback means for feeding back the output difference signal from the optical phase detector of the frequency discriminator to the laser.

28. The laser stabilisation apparatus of claim 27 comprising at least one additional frequency discriminator apparatus, each frequency discriminator apparatus

having corresponding feedback means for feeding back the electrical output from the associated optical phase detector to the laser.

29. The laser stabilisation apparatus of claim 28, wherein the outputs from the optical phase detectors of the different frequency discriminators feed back to different control points on the laser.

30. The laser stabilisation apparatus of any of claims 27-29, wherein the optical phase detector includes a voltage-controlled electro-optic phase modulator for modulating the phase of one of the primary optical outputs which is input to the optical phase detector, the electro-optic phase modulator having a substantially linear response.

31. The laser stabilisation apparatus of any of claims 27-29, including a differential amplifier, the output from the optical phase detector being fed back to an input of the differential amplifier, the output from the differential amplifier being fed back to the laser.

32. The laser stabilisation apparatus of any of claims 27-29, wherein the optical phase detector forming part of the laser stabilisation apparatus comprises coupling means for receiving the two optical inputs and producing the two combined optical outputs.

33. An optical frequency synthesizer comprising;

the laser stabilisation apparatus of claim 27 for stabilising an output from a laser, and

means for varying the frequency of the laser output.

34. The optical frequency synthesiser of claim 33, including two optical fibres for introducing a relative delay between the two primary optical outputs, the two optical fibres having different optical path lengths.

35. The optical frequency synthesiser of claim 34, comprising an electro-optic phase modulator arranged in the path of one of the lengths of optical fibres, whereby application of a SAWTOOTH-like voltage waveform to the electro-optic phase modulator gives rise to a variation of the frequency of the laser output.

36. The optical frequency synthesizer of claim 35 and further comprising a voltage source, providing a SAWTOOTH-like voltage waveform, for applying a voltage to the electro-optic phase modulator.

37. The optical frequency synthesiser of claim 33, comprising a differential amplifier, the output from the optical phase detector being fed back to an input of the differential amplifier, the output from the differential amplifier being fed back to the laser.

38. The optical frequency synthesiser of claim 33, wherein the optical phase detector includes an electro-optic modulator.

42. A method of stabilising the output frequency from a laser comprising the steps of;

providing a frequency discriminator apparatus comprising input means,

inputting a primary optical input from the laser to the input coupling means and producing two primary optical outputs,

introducing a relative delay between the two primary optical outputs,

inputting the two primary optical outputs to an optical phase detector, comprising

coupling means for receiving the two optical inputs and producing two combined optical outputs,

detecting the intensity of each of the two combined optical outputs;

converting the intensity of each of the combined optical outputs into an electrical signal,

measuring the difference between the two electrical signals and generating an output difference signal, and

feeding back the output difference signal from the optical phase detector of the frequency discriminator to the laser.

43. A laser stabilisation apparatus for stabilising the output frequency of a laser comprising:

an input waveguide,

a beam divider having an input and first and second outputs, the input waveguide in optical communication with the input to the beam divider

first and second waveguides in optical communication with the first and second outputs respectively, the first waveguide being comprised of an optical delay means

a beam combiner having first and second inputs and two outputs, the first and second waveguides being in optical communication with the first and second inputs of the beam combiner, respectively,

two detectors, each detector receiving radiation from a different output of the beam combiner, the output of each detector being connected to a differential circuit, and

laser feedback means responsive to the differential circuit.